MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2210 & TERM ID 2215)

PPP0101 PRINCIPLES OF PHYSICS

(Foundation in Information Technology)

17 FEBRUARY 2023
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 7 printed pages, including the cover page and appendices, with 4 questions only.
2. Answer all questions.
3. Write your answers on the answer sheets given.
4. Show all relevant steps to obtain maximum marks.

QUESTION 1 (10 MARKS)

a) The coefficient of static friction between a block and a horizontal floor, μ_s is 0.53, while the coefficient of kinetic friction, μ_k is 0.37. The mass of the block is 10.0 kg. A horizontal force is applied to the block and slowly increased.

(i) Draw the free body diagram of the block.

[2 marks]

(ii) Calculate the value of the applied horizontal force at the instant that the block is about to slide.

[2 marks]

(iii) Calculate the kinetic friction force on the block after it starts to slide.

[2 marks]

(iii) Calculate the net force on the block after it starts to slide.

[2 marks]

(iv) Calculate the magnitude of acceleration of the block after it starts to slide.

[2 marks]

QUESTION 2 (10 MARKS)

a) Sketch a diagram to show how you measure the amplitude and the period of a horizontal mass-spring system and a pendulum system.
[Hint: Sketch both systems and label the amplitude and the period accordingly.]

[4 marks]

b) In a horizontal mass-spring system, a 1.0 kg mass vibrates according to the equation $x = 0.50 \cos (8.40\, t)$ where x is in meters and t is in seconds. Determine

(i) the amplitude

[1 mark]

(ii) the frequency

[1 mark]

(iii) the total energy

[2 marks]

(iv) the kinetic energy when $x = 0.160$ m.

[2 marks]

QUESTION 3 (15 MARKS)

a) Sketch the transverse wave and longitudinal wave formed by a slinky spring. Give one example of transverse wave and longitudinal wave.

[4 marks]

b) Define node and antinode of a standing wave. Hint: You may sketch diagram as an aid.

[2 marks]

Continued...

c) At $t = 0$ and $x = 0$, a sinusoidal wave is travelling in the positive-x direction and has a maximum displacement of 5 m. Its wavelength is 4 m.

(i) Determine the speed of the wave if it takes 0.2 s to travel one wavelength.

[2 marks]

(ii) Write the wave equation that represents this wave. [Hint: Find k and ω. Then, construct the equation using sine function.]

[4 marks]

d) What is the intensity of sound at the pain level of 120 dB?

[1 mark]

e) The predominant frequency of a certain police car's siren is 1000 Hz when at rest. What frequency do you detect if you move with a speed of 25 m/s , toward the car. Take the speed of sound in air as 343 m/s.

[2 marks]

QUESTION 4 (15 MARKS)

a) Copy the **Figure Q4(a)** and label which part reflection, refraction, diffraction or total internal reflection of light, occurs, if any.

[2 marks]

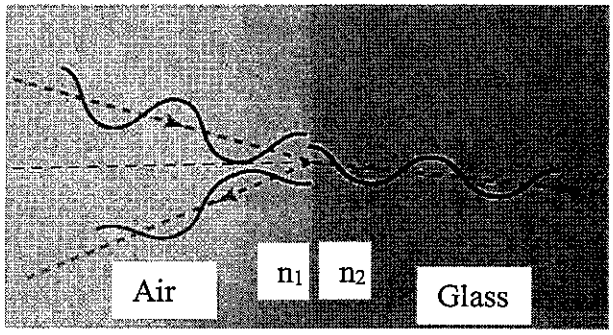

Figure Q4(a)

b) State the meaning of the following terms: [Hint: You may sketch diagram as an aid.]

(i) Total internal reflection

[1 mark]

(ii) Diffraction

[1 mark]

(iii) Snell's law

[1 mark]

(iv) Index of refraction

[1 mark]

c) State two conditions for total internal reflection to occur.

[2 marks]

Continued...

d) Sketch the outcome of following interference of light:

i) ii)

[2 marks]

e) What is the minimum index of refraction for a glass or plastic prism to be used in binoculars as shown in **Figure Q4(e)** so that total internal reflection occurs at 45°?

[2 marks]

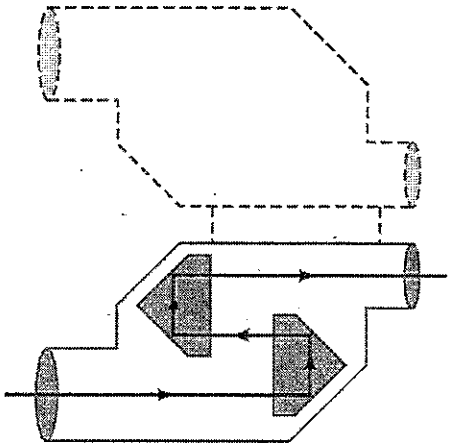

Figure Q4(e)

f) A pair of narrow, parallel slits separated by 6.75 μm is illuminated by the green light from a mercury vapor lamp (λ = 445 nm). The interference pattern is observed on a screen 2.30 m from the plane of the parallel slits. Calculate the

(i) distance from the central maximum to the first bright region on either side of the central maximum, [2 marks]

(ii) distance between the first and second dark bands in the interference pattern. [1 mark]

End of questions.

APPENDIXES

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^{2}kg^{-2}
Universal gas constant,	R	=	8.314 J/K.mol
Hydrogen ground state,	E_o	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_χ	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	=	9.81 m s^{-2}
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_o	=	1.0×10^{-12} W m^{-2}
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 Nm^2 C^{-2}
Permittivity of free space,	ε_o	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ (T.m)/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

Continued...

LIST OF FORMULA

Differential Rule

$$y = kx^n$$

$$\frac{dy}{dx} = knx^{n-1}$$

Trigonometric Identity

$$\sin\theta = \frac{opposite}{hypotenuse} \qquad \cos\theta = \frac{adjacent}{hypotenuse}$$

$$\tan\theta = \frac{opposite}{adjacent}$$

$$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$$

$$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$$

NEWTONIAN MECHANICS

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v = v_o + at \qquad x - x_o = v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2a(x - x_o) \qquad x - x_o = \left(\frac{v_o + v}{2}\right)t$$

$$v = v_o + gt \qquad y - y_o = v_o t + \frac{1}{2}gt^2 \qquad v^2 = v_o^2 + 2g(y - y_o) \qquad y - y_o = \left(\frac{v_o + v}{2}\right)t$$

$$W = Fs\cos\theta \qquad W = mg \qquad \sum F = F_{net} = ma \qquad f_s \le \mu_S F_N$$

$$f_k = \mu_K F_N \qquad K = \frac{1}{2}mv^2 \qquad PE_s = \frac{1}{2}kx^2 \qquad F_s = -kx$$

$$PE_G = mgy \qquad T_s = 2\pi\sqrt{\frac{m}{k}}$$

Spring with mass, $\omega = \sqrt{\frac{k}{m}}$ Simple pendulum, $\omega = \sqrt{\frac{g}{l}}$ $T_p = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{2\pi}{\omega} = \frac{1}{f}$

Cosine Wave:

$$x = A\cos\omega t$$
$$v = -\omega A\sin\omega t$$
$$a = -\omega^2 A\cos\omega t$$

Sine Wave:

$$x = A\sin\omega t$$
$$v = \omega A\cos\omega t$$
$$a = -\omega^2 A\sin\omega t$$

WAVES AND OPTICS

$$v = f\lambda \qquad \omega = 2\pi f \qquad n = \frac{c}{v} \qquad n_1\sin\theta_1 = n_2\sin\theta_2$$

$$\sin\theta_c = \frac{n_2}{n_1} \qquad \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \qquad M = -\frac{d_i}{d_o} = \frac{h_i}{h_o} \qquad f = \frac{R}{2}$$

$$d\sin\theta_{max} = m\lambda \qquad d\sin\theta_{min} = (m + \frac{1}{2})\lambda$$

$$y_{bright} = \frac{m\lambda L}{d} \qquad y_{dark} = (m + \frac{1}{2})\frac{\lambda L}{d} \qquad I = \frac{P}{A} \qquad \beta = 10\log_{10}\frac{I}{I_o}$$

Continued...

$$f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right) \qquad y(x,t) = A\sin(kx \pm \omega t + \phi)$$

Wave Type:

$$y(x,t) = 2A\cos\left(\frac{\phi}{2}\right)\sin(kx - \omega t - \frac{\phi}{2})$$

$$y(x,t) = 2A\sin\ kx\ \cos\omega t$$

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